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(71) Applicant: APPLIED MATERIALS, INC. [US/US]; P.O. Box 450A, Santa Clara, CA 95052 (US).

(72) Inventors: WHITE, Anthony; 20061 Forest Avenue, Cupertino, CA 95014 (US). SMARGIASSI, Eugene; 6148 Dunn Avenue, San Jose, CA 95123 (US). JENNINGS, Dean, C.; 2898 Morgan Drive, San Ramon, CA 94583 (US).

(74) Agents: BERNADICOU, Michael, A. et al.; Blakely, Sokoloff, Taylor & Zafman LLP, 7th Floor, 12400 Wilshire Boulevard, Los Angeles, CA 90025 (US).

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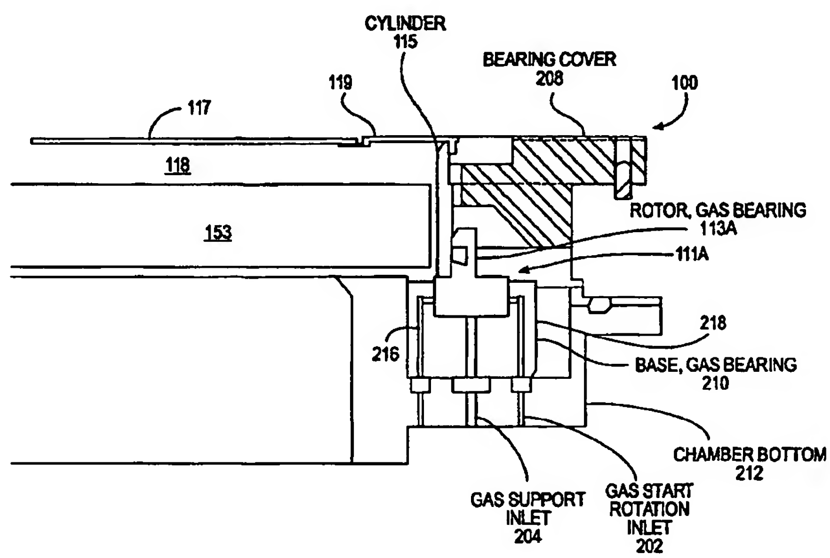

(57) Abstract: A substrate processing chamber (100) includes a substrate support (119) to support a substrate (117) in the chamber. A rotor (113) is coupled to the substrate support such that rotation of the rotor causes rotation of the substrate support. A gas bearing provides vertical support for the rotor. Using a gas bearing, instead of mechanical bearings, to provide vertical levitation of the rotor can help reduce the amount of particle generation resulting from mechanical wear of the bearings. Various techniques can be used to control rotation of the gas bearing rotor system including driving the rotor using a magnetically coupled system.

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GAS BEARING ROTATION ASSEMBLIES FOR SUBSTRATE PROCESSING SYSTEMS

BACKGROUND

The present invention relates to gas bearing rotation assemblies for substrate processing systems.

Rapid thermal processing (RTP) system technologies have been developed to increase manufacturing throughput of wafers while minimizing their handling. The uniformity of the process over the surface of the substrate during thermal processing is critical to producing uniform devices. High levels of uniformity require that temperature variations across the substrate during high temperature processing not exceed a few degrees Celsius (°C). Therefore, techniques that minimize temperature non-uniformity are important.

One way to achieve temperature uniformity is to rotate the substrate during processing so that all points along annular regions of the wafer (at any arbitrary radius) are exposed to the same amount of illumination in the RTP chamber. An example of a mechanical rotation system is shown in FIG. 1. In this type of mechanical rotation system, a wafer support is rotatably mounted on a bearing assembly that is coupled to a vacuum-sealed drive assembly. As shown in FIG. 1, a wafer 12 is placed on an edge ring 14 that is friction-fit on a cylinder 16.

bearing race 21. The upper bearing race 21 is disposed within a well 39 and, as a result of ball bearings 22, rotates relative to a lower bearing race 26. The lower bearing race 26 is mounted generally at a chamber bottom 28. A water-cooled reflector 24 is positioned on the chamber bottom 28 as part of a temperature measuring system. A magnet 30 is located adjacent a portion of the chamber bottom 28 opposite the upper magnetic bearing race 21. The magnet 30 is mounted on a motor-driven magnet ring 32 and is coupled to the magnetic bearing race 21 through the chamber bottom 28. By mechanically rotating the magnet 30 about the central axis of the chamber bottom 28, the upper bearing race 21 can be made to rotate. In particular, torque is transferred to the upper bearing race 21 from the motor-driven magnet ring 32. Rotation of the upper magnetic bearing race 21 causes rotation of the cylinder 16, the edge ring 14 and, therefore, the wafer 12.

While fully capable of accomplishing the intended function, the foregoing system has some disadvantages. For example, sliding and rolling contact associated with the ball bearings leads to particle generation in the processing chamber. The particle generation arises from the contact between the ball bearings and the races as well as from the necessary use of lubrication for the bearing system.

Another disadvantage can result from complicated rotational mechanisms that are sometimes damaged by the reactive process gases in other parts of the chamber. Such mechanisms often are particularly delicate and are unable to withstand the corrosion and other damage caused by hot process gases. A related disadvantage can occur when gaseous products of the chemical reactions on the wafer are not fully exhausted through a pumping system. Some of those gases may escape the pumping system and flow to regions below the plane of the wafer. The reactive gases can deleteriously affect various parts of the processing chamber including the well containing the bearing/race system. Many of the sensitive components relating to rotation may be located in this well. In particular, damage and corrosion may be caused to the bearings by the presence of hot gases in these regions.

SUMMARY

In general, the techniques described in greater detail below include providing a gas bearing to support a rotor system in a substrate processing chamber.

In one aspect, operating a substrate processing chamber includes providing a gas bearing to support a rotor coupled to a substrate support.

A substrate processing chamber also is disclosed and includes a substrate support to support a substrate in

support. Rotation of the rotor causes rotation of the substrate support. A gas bearing provides vertical support for the rotor.

Using a gas bearing, instead of mechanical bearings, to provide vertical support for the rotor can provide various advantages. For example, the amount of particle generation resulting from mechanical wear of the bearings can be reduced.

Various techniques can be used to control rotation of the gas bearing rotor system. One technique uses the pressure of gas directed laterally against surfaces of the rotor to control the rotation. Alternatively, a motor-driven assembly can include magnets that are coupled magnetically to corresponding magnetic elements in the rotor. When the motor-driven assembly is caused to rotate, torque can be transferred to the rotor causing it to rotate. In yet another implementation, a motor stator includes windings that are energized. When the windings are energized, magnetic coupling between the windings and a magnetic plate that is coupled to the rotor causes rotation of the rotor. To increase the speed of rotation of the rotor, the frequency of an AC signal applied to the windings can be increased. Similarly, to decrease the speed of rotation of the rotor, the frequency of the AC signal applied to the windings can be decreased. The phases of AC signals

applied to adjacent windings can be out of phase by a predetermined amount.

Other features and advantages will be readily apparent from the following detailed description, the accompanying drawings and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a prior art mechanical bearing and rotation system used in an RTP chamber.

FIG. 2 is a cross-sectional view of an exemplary RTP chamber.

FIG. 3 is an enlarged partial cross-sectional view of the RTP chamber view according to one embodiment of the invention.

FIG. 4 is a partial top view of a rotor assembly in the embodiment of FIG. 3.

FIG. 5 is an enlarged partial cross-sectional view of the RTP chamber view according to a second embodiment of the invention.

FIG. 6 illustrates a partial cross-sectional view of an RTP chamber according to a third embodiment of the invention.

FIG. 7 is a top plan view of the chamber of FIG. 6.

FIG. 8 is a partially exploded view of the chamber of FIG. 6.

FIG. 9 is a graph illustrating a phase relationship between signals applied to the windings.

DETAILED DESCRIPTION

FIG. 2 shows an RTP processing chamber 100 for processing a disk-shaped, twelve-inch (300 millimeter (mm)) diameter silicon (Si) substrate 117. Substrates of other materials also may be used. The substrate 117 is mounted inside the chamber 100 on a rotor system 111 and is heated by a heating element 110 located directly above the substrate 117.

The rotor system 111 includes an edge ring or other substrate support 119, a quartz support cylinder 115 and a rotor 113. The substrate 117 is placed on the edge ring 119 which is mounted on the support cylinder 115. The support cylinder 115 is coupled to the rotor 113. During processing of the substrate 117, the rotor system 111 is rotated to cause rotation of the substrate in the chamber. Further details of the rotor system 111 are discussed below.

The heating element 110 generates radiation 112 which may enter the processing chamber 100 through a water-cooled quartz window assembly 114. Beneath the substrate 117 is a reflector 153 mounted on a central assembly 151 having a generally cylindrical base. The underside 165 of the substrate 117 and the top of the

reflector 153 form a reflecting cavity 118 for enhancing the effective emissivity of the substrate.

The temperatures at localized regions 102 of the substrate 117 are measured by temperature probes each of which includes a sapphire light pipe 126 inserted into a conduit 124 that passes from the backside of central assembly 151 through the top of reflector 153. Light pipes 126 are connected to pyrometers 128 via optical fibers 125 which produce a signal indicative of the measured temperature. The central assembly 151 includes a circulation circuit including chambers 146 for cooling the reflector 153.

A processing region 163 is located generally above the substrate 117. Process gases can be used in conjunction with the temperature control of the substrate 117 via lamps 110 to conduct chemical reactions on the substrate 117. The process gases typically emerge into the processing region 163 through a gas inlet 177. The process gases may be pumped out of the chamber or exhausted by a pumping system 179.

FIG. 3 illustrates an implementation of a rotor system 111A for use in the chamber 100. The support cylinder 115 supports the edge ring 119 and is supported by and coupled to the rotor 113A. In this implementation, levitation of the rotor 113A, as well as rotation of the rotor, is controlled by providing gas

208 is provided over the rotor assembly, and a base 210 is disposed about the lower portion of the rotor assembly. The outer wall of the chamber 100 is identified by the reference number 212.

As shown in FIG. 3, gas is provided through center inlets 204 to provide a gas bearing and maintain an upward pressure against the bottom of the rotor 113A. The upward pressure supports the rotor 113A and keeps the rotor in its proper vertical position in contact with the cylinder 115. The other sets of inlets 202, 206 are arranged, respectively, to provide lateral pressure against inner and outer surfaces of the rotor 113A, as illustrated in FIG. 4. By controlling the gas flow through the inlets 202, 206, rotation of the rotor 113A can be controlled. For example, when gas flows only through the inlets 202, the rotor 113A is caused to rotate in a first direction indicated by the arrow 214. In general, the relative rates of gas flow through the sets of inlets 202, 206 can be used to control the starting, stopping and speed of rotation of the rotor 113A. Thus, to slow the speed of rotation or to stop rotation of the rotor 113A, the flow of gas through the inlets 206 can be increased. A controller (not shown) can be used to control valves (not shown) to control the rates of gas flow through the inlets 202, 204, 206. In some implementations, in addition to the vertical gas

inject ports, gas inject ports may be provided along only the inner or outer radius of the rotor.

Various gases can be used to provide the air bearing and maintain levitation of the rotor 113A, as well as to control rotation of the rotor. Exemplary gases include nitrogen and inert gases such as argon and helium. In some cases, the same gases used for processing the substrate 117 can be used. The rotor 113A can be formed, for example, of aluminum or stainless steel and should have relatively smooth surfaces. Clearances should be provided between the rotor 113A and the sidewalls of the base 210 to allow for thermal expansion of the rotor. In some situations, it may be desirable to make the clearance between the rotor 113A and the inner wall 216 of the base 210 somewhat smaller than the clearance between the rotor and the outer wall 218 of the base.

FIG. 5 illustrates another implementation of a rotor system 111B for use in the chamber 100. The support cylinder 115 supports the edge ring 119 and is supported by and coupled to the rotor 113B. In this implementation, levitation of the rotor 113B is controlled by providing gas through a set of inlets 300. A cover 308 is provided over the rotor assembly, and a base 310 forms the lower portion of the rotor assembly. The outer wall of the chamber is identified by the reference number 312.

As shown in FIG. 5, gas is provided through the inlets 300 to provide a gas bearing and maintain an upward pressure against the bottom of the rotor 113B. The upward pressure supports the rotor 113B and keeps the rotor in its proper vertical position adjacent the cylinder 115. The lower surface 322 of the rotor 113B can be slanted at an angle, with the gas from the inlets 300 directed perpendicularly to the lower surface. That allows the gas bearing to provide lateral, as well as vertical, support, thereby reducing wobble of the rotor 113B.

The rotor 113B includes a recess along its bottom surface to allow the gas to circulate and spread along the bottom surface 322, thereby providing more uniform support of the rotor. A set of outlets 302 provides a return path for the gas so that the gas can be re-circulated. The upper end of the recess 320 can be made somewhat narrower than the remainder of the recess so as to force the gas toward the outlets 302. In addition, a pump (not shown) can be provided to pull the gas out of the outlets 302 and increase circulation of the gas. A controller (not shown) can be used to control valves (not shown) and, thus, control the rate of gas flow through the inlets 300.

To control rotation of the rotor assembly 111B, a motor-driven assembly 324 can be provided outside the

located in an upper section 326 opposite the rotor 113B. The magnets in the upper section 326 of the assembly 324 are magnetically coupled to corresponding magnetic elements located in a lower section 328 of the rotor 113B. The assembly 324 also includes a gear 330 with teeth along an outer wall of the assembly 324. During operation, a motor (not shown) drives the gear 330 to cause rotation of the assembly 324. As the assembly 324 rotates, coupling of the magnets in the upper section 326 of the assembly and the corresponding magnetic elements in the lower section 328 of the rotor transfers torque to the rotor 113B. Rotation of the rotor 113B, in turn, causes rotation of the cylinder 115, the edge ring 119 and, therefore, the substrate 117.

In another implementation, shown in FIGS. 6A and 6B, rotation of the rotor system 111C can be achieved, as described below, by energizing magnetic coils to create a magnetic torque on the rotor and cause it to spin.

As shown in FIGS. 6, 7 and 8, the rotor system 111C includes a gas bearing base 410 with a set of gas inlets 400 oriented vertically. Gas is provided through the inlets 400 to cause levitation of the rotor 113C. In FIG. 7, the inner diameter of the air bearing base 410 and rotor 113C is identified by 402. The outer diameter of the reflector 153 is identified by 430.

An outer wall of the RTP chamber is identified by

outer diameter of the chamber wall 412 is identified by 428. The thin wall section 414 can be formed, for example, of type 303 stainless steel, type 316L stainless steel or aluminum.

A magnetic plate 416 is coupled to the rotor 113C on the chamber-side of the thin wall section 414 and can be formed, for example, of type 17-4 stainless steel. In FIG. 7, the outer diameter of the magnetic plate 416 is identified by 418. A series of magnetic teeth 424 extend along the outer diameter 418 of the magnetic plate 416. As shown in FIG. 7, there are eight teeth 424 separated from one another by gaps 426. The teeth 424 can be formed, for example, of 400 series stainless steel.

On the opposite side of the thin wall section 414 of the chamber wall 412 is a motor stator 420 that includes magnetic windings 422. The windings 422 can be formed, for example, of copper wire wound about key-shaped elements 423 on the stator 420. As illustrated in FIG. 7, there are a total of forty-eight windings equally-spaced along the inner radius of the motor stator 420. The windings 422 can be energized by a remote controller (not shown) and become magnetized when energized. The magnetic flux between the energized windings 422 and the teeth 424 create a torque on the rotor, causing it to spin.

Operation of the system of FIG. 6 is as follows.

rotor system 111C is at rest. The windings 422 then are energized synchronously by applying an ac signal to them. Preferably, the ac signal applied to each winding 422 is shifted in phase by 120° from adjacent windings (see FIG. 9). In other words, every third winding 422 (e.g., winding A) would be energized with an ac signal at a particular frequency and a particular phase. Adjacent windings (e.g., winding B in the clockwise direction) would be energized at the same frequency with a phase shift of 120° with respect to the first group of windings. The remaining windings 422 (e.g., winding C) would be energized at the particular frequency with a phase shift of 240° with respect to the first group of windings and with a phase shift of 120° with respect to the second group of windings.

In one implementation, the initial frequency of the ac signal applied to the windings 422 is 1 hertz (Hz). To increase the speed of rotation, the frequency of the ac signal is increased. In one implementation, the rate at which the frequency is increased should not exceed about 0.75 Hz/second. Increasing the speed of the rotor system using the foregoing technique can provide more stable and smooth rotations as well as higher rotational speeds. For example, in one implementation, rotational speeds of up to 300 rotations per minute (rpm), in other words 5 Hz, can be obtained. To reduce the rotational

of the ac signal applied to the windings 422 is decreased.

Although the illustrated implementation includes forty-eight windings 422, a greater or lesser number can be used. In general, the windings 422 should be placed symmetrically about the rotor system.

One or more Hall-effect sensors can be provided on the stator 420 to measure the rotor's speed of rotation by counting the number of magnetic teeth 424 that pass within a given time interval.

The invention has been described in terms of a number of implementations. The invention, however, is not limited to the implementations depicted and described. Other implementations are within the scope of the following claims.

What is claimed is:

1. A substrate processing chamber comprising:

a substrate support to support a substrate in the chamber;

a rotor coupled to the substrate support, wherein rotation of the rotor causes rotation of the substrate support; and

a gas bearing providing vertical support for the rotor.

2. The chamber of claim 1 including first inlets through which a gas can pass to provide the gas bearing.

3. The chamber of claim 1 including at least one set of inlets through which a gas can pass, wherein gas exiting the sets of inlets flows laterally.

4. The chamber of claim 3 wherein rates of gas flowing through the at least one set of inlets is controllable to cause, maintain and stop rotation of the rotor.

5. The chamber of claim 1 including a first set of inlets through which gas can pass to provide the gas bearing, and second and third sets of inlets through which gas can pass, wherein gas exiting the second and third sets of inlets flows laterally, and wherein rates of gas-flow through the second and third sets of inlets are controllable to determine the speed of rotation of the rotor.

6. The chamber of claim 5 wherein gas exiting the second and third sets of inlets is directed against opposing surfaces of the rotor.

7. The chamber of claim 1 wherein the gas bearing is positioned with respect to the rotor to provide both vertical and lateral support for the rotor.

8. The chamber of claim 2 including inlets through which gas can flow to form the gas bearing and outlets from which the gas can flow away from the rotor for recirculation.

9. The chamber of claim 8 wherein the rotor includes a recess having a surface along which the gas from the inlets flows.

10. The chamber of claim 1 including a motor-driven assembly having magnets magnetically coupled to corresponding magnetic elements in the rotor, wherein rotation of the motor-driven assembly causes rotation of the rotor.

11. The chamber of claim 1 including:

a magnetic plate coupled to the rotor; and

a motor stator having windings, wherein when the windings are caused to be energized, magnetic coupling

between the windings and the magnetic plate causes rotation of the rotor.

12. The chamber of claim 11 wherein the magnetic plate includes magnetic elements extending along its outer diameter, wherein the magnetic elements are located on a side of a wall opposite from the windings, wherein when energized, magnetic coupling between the windings and the magnetic elements causes rotation of the rotor.

13. The chamber of claim 11 wherein, to increase a speed of rotation of the rotor, the frequency of an AC signal applied to the windings is increased.

14. The chamber of claim 13 wherein, to decrease a speed of rotation of the rotor, the frequency of the AC signal applied to the windings is decreased.

15. The chamber of claim 13 wherein phases of AC signals applied to adjacent windings are out of phase by a predetermined amount.

16. A method of operating a substrate processing chamber, the method comprising:

providing a gas bearing to support a rotor coupled to a substrate support; and

rotating the rotor to cause rotation of the substrate support.

17. The method of claim 16 including causing rotation of the rotor while a substrate is supported by the substrate support.

18. The method of claim 16 wherein causing rotation of the rotor includes passing gas through a first set of inlets, wherein the gas exiting the first set of inlets is directed laterally against a first surface of the rotor.

19. The method of claim 18 including passing gas through a second set of inlets, wherein the gas exiting the second set of inlets is directed against a second surface of the rotor.

20. The method of claim 16 wherein causing rotation of the rotor includes causing rotation of a motor-driven assembly that is magnetically coupled to the rotor.

21. The method of claim 16 wherein causing rotation of the rotor includes energizing windings that, when energized, are magnetically coupled to a plate coupled to the rotor.

22. The method of claim 21 including increasing a frequency of an AC signal applied to the windings to increase a speed

23. The method of claim 22 including decreasing a frequency of the AC signal applied to the windings to decrease the speed of rotation of the rotor.

24. The method of claim 22 wherein phases of AC signals applied to adjacent windings are out of phase by a predetermined amount.

25. A method of operating a substrate processing chamber, the method comprising:

providing a gas bearing to support a rotor that is coupled to a substrate support;

energizing windings that are magnetically coupled to a magnetic plate coupled to the rotor to cause rotation of the rotor while a substrate is supported by the substrate support;

increasing a frequency of an AC signal applied to the windings; and

subsequently decreasing the frequency of the AC signal applied to the windings.

26. The method of claim 25 wherein phases of AC signals applied to adjacent windings are out of phase by a predetermined amount.

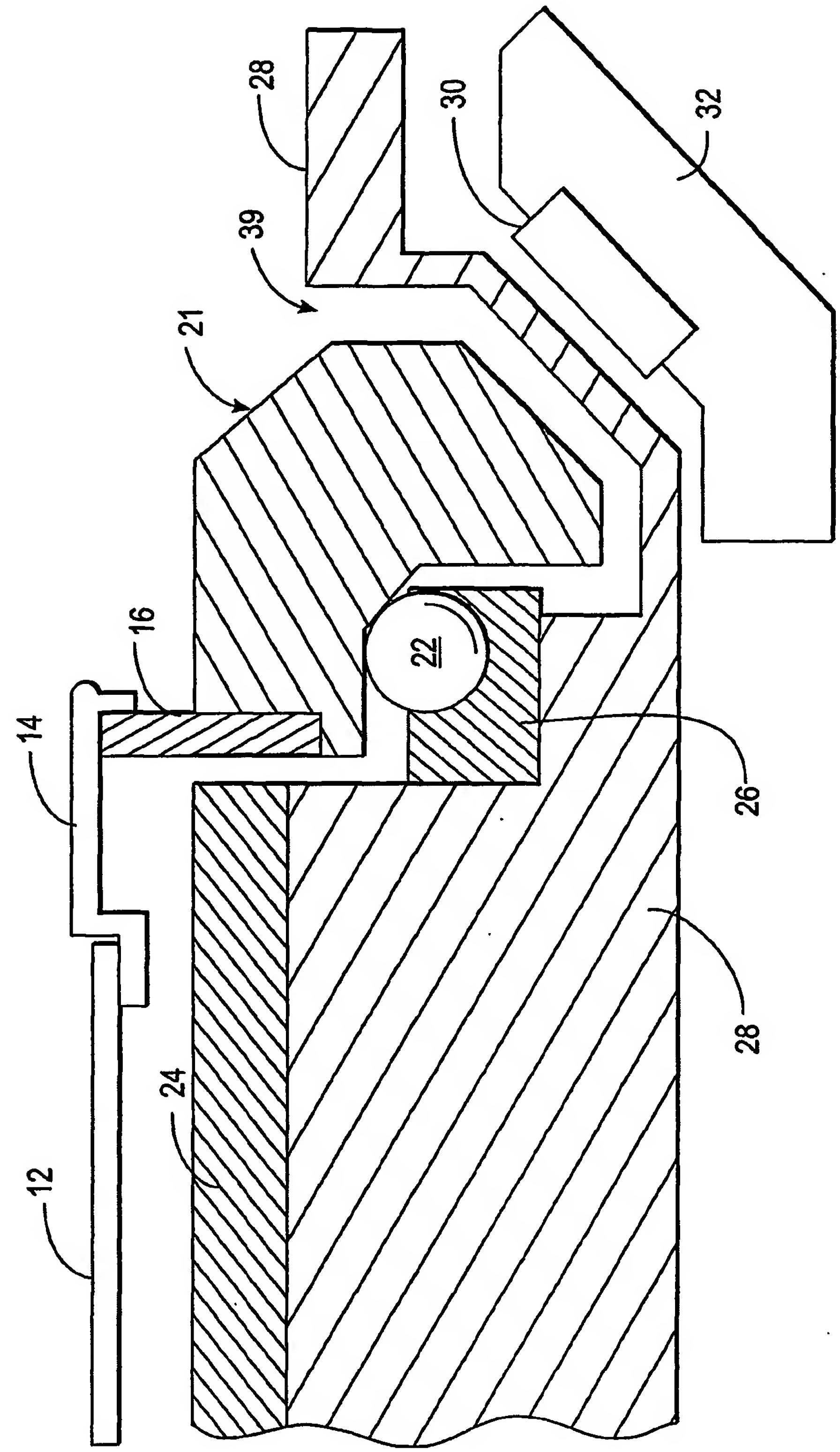
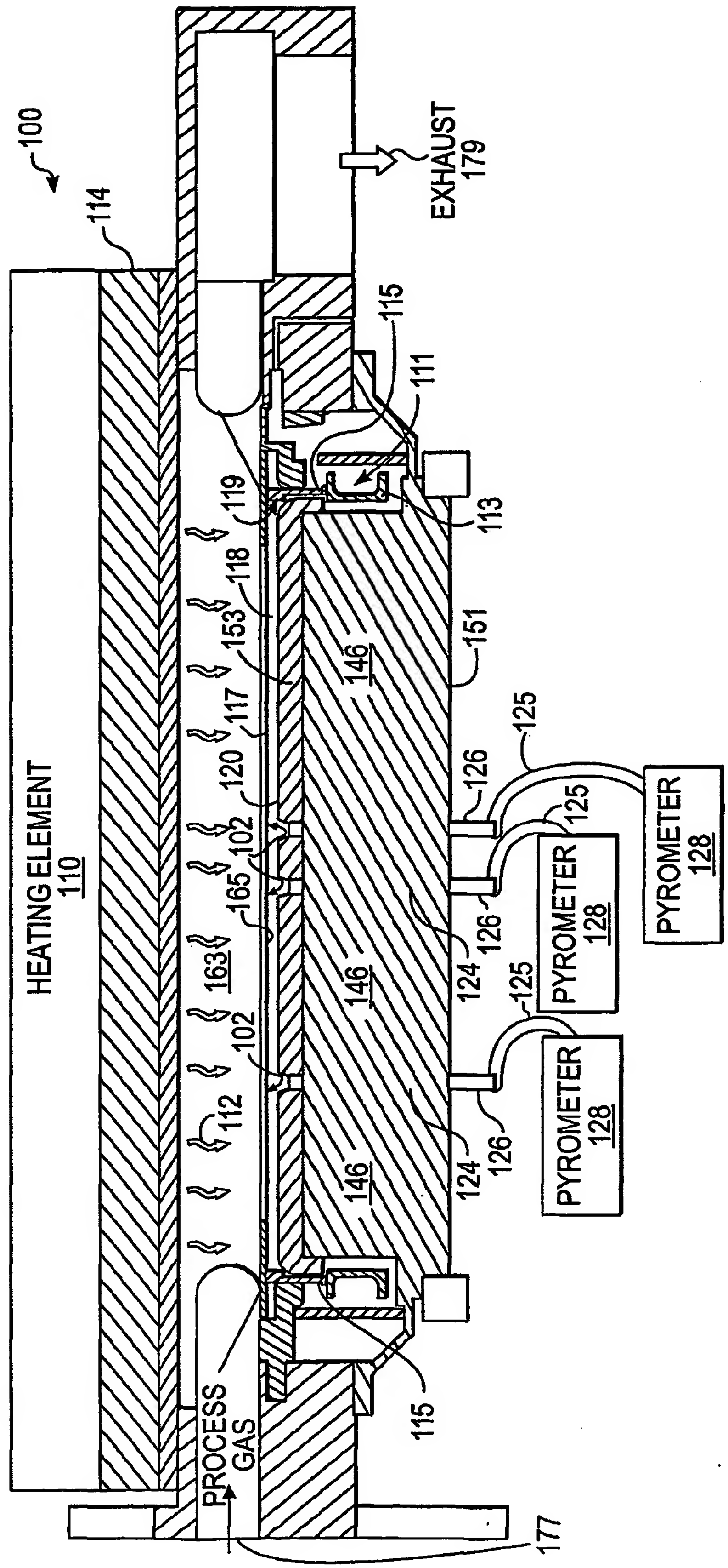


Fig. 1
(Prior Art)



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PYROMETER 128
PYROMETER 128
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Fig. 2

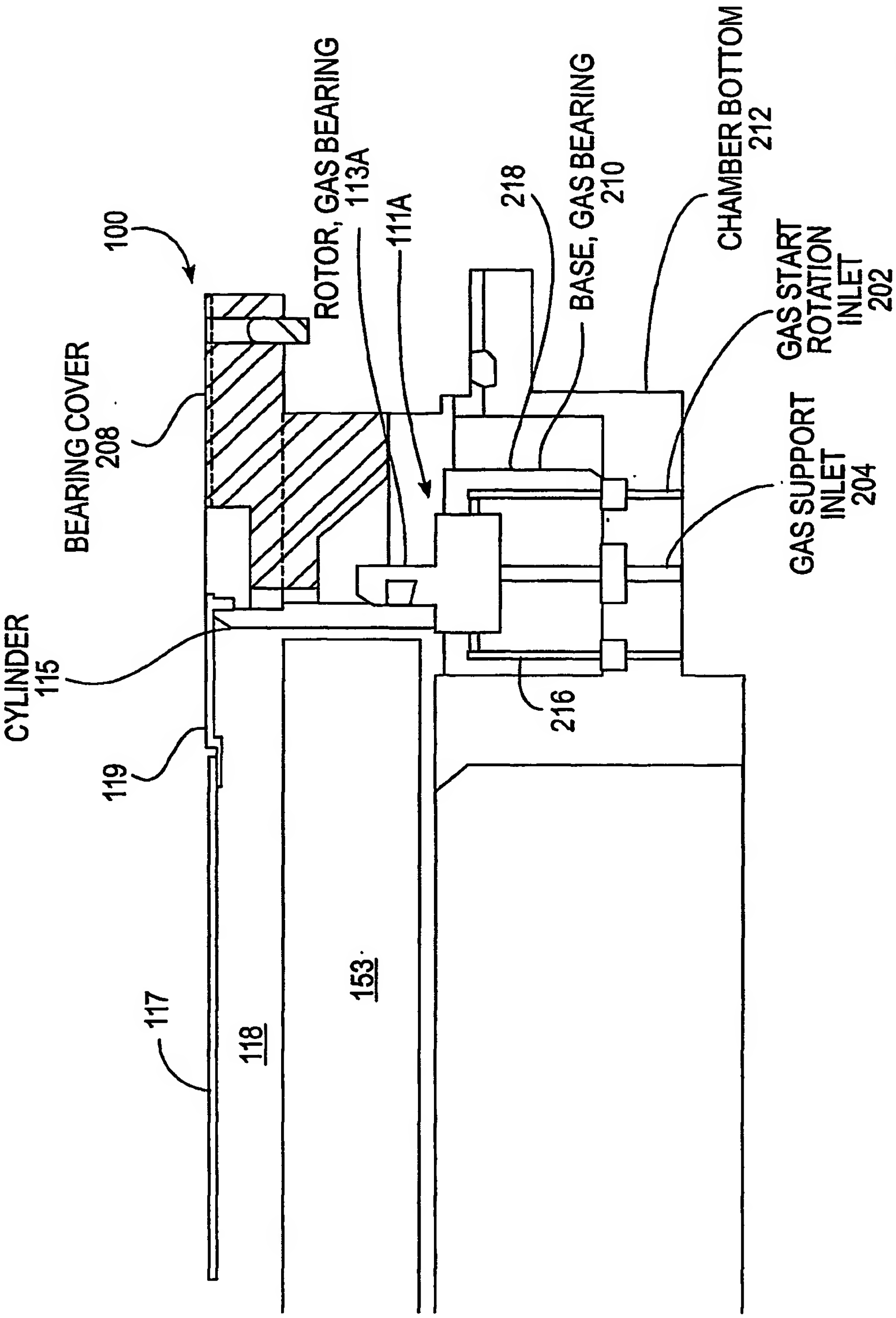
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Fig. 3

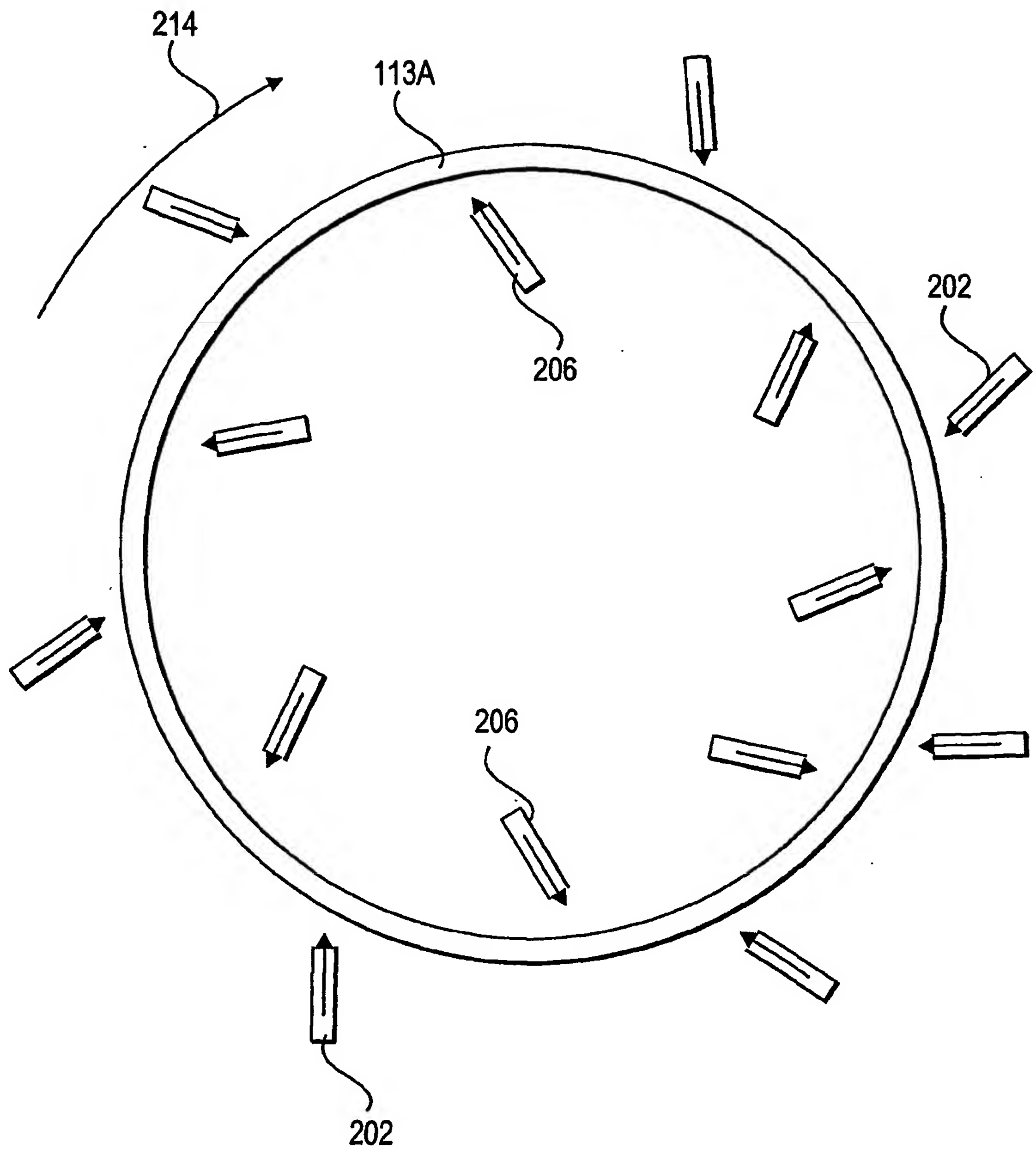

Fig. 4

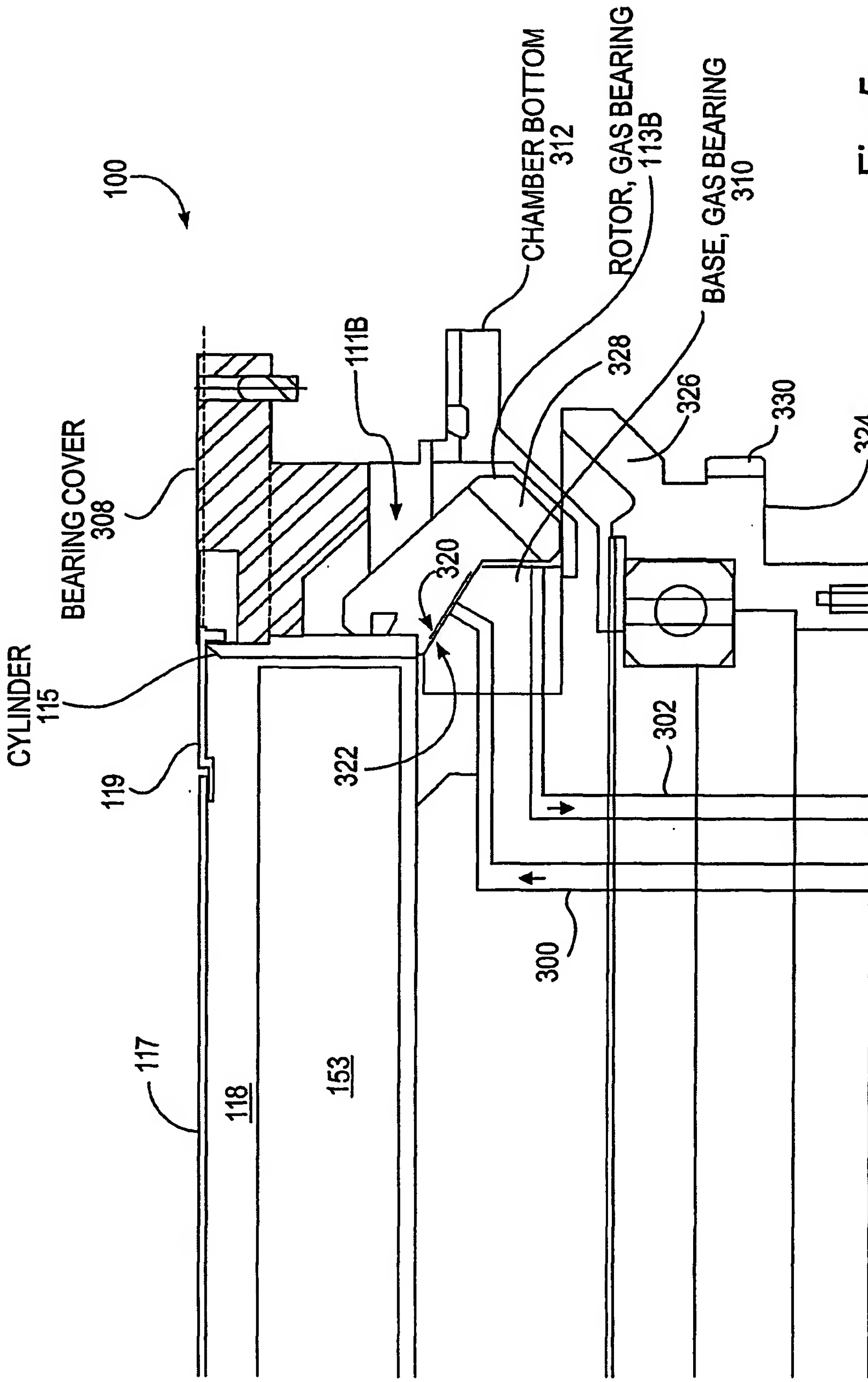
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Fig. 5

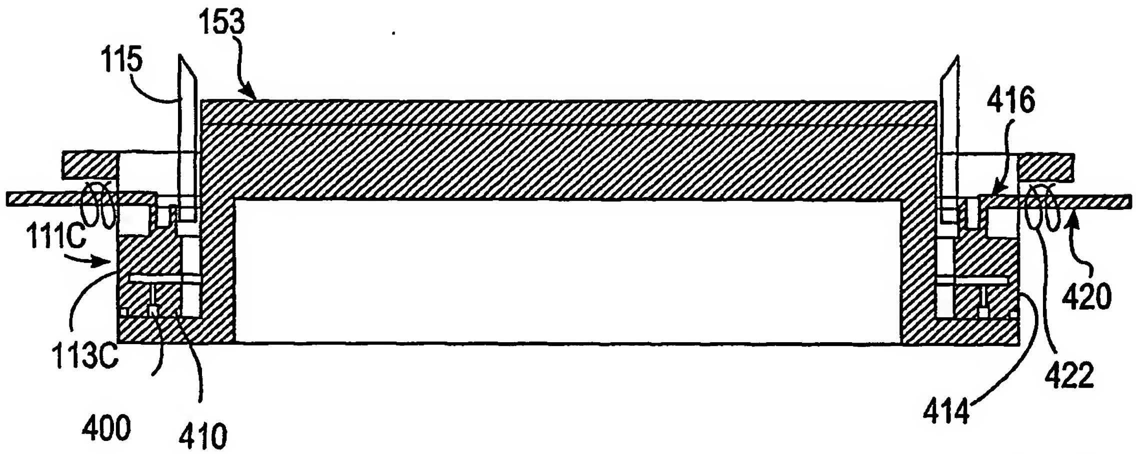
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Fig. 6

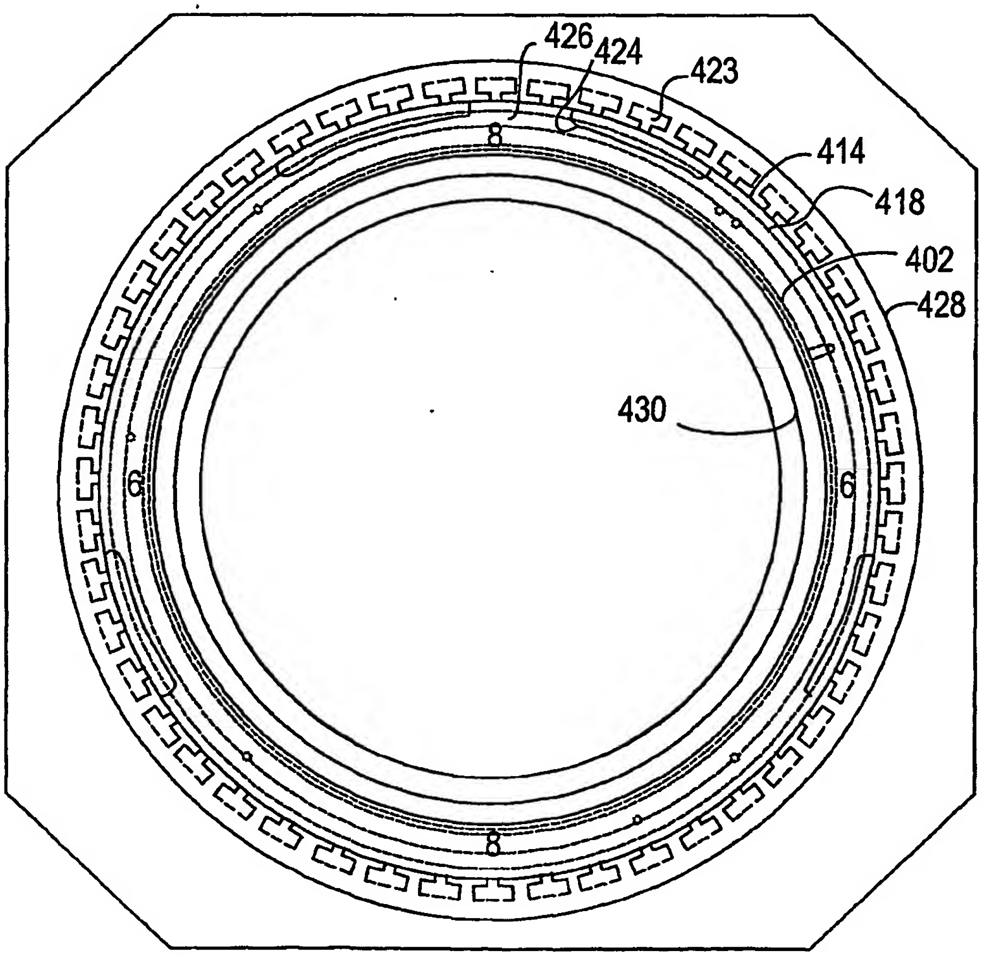
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Fig. 7

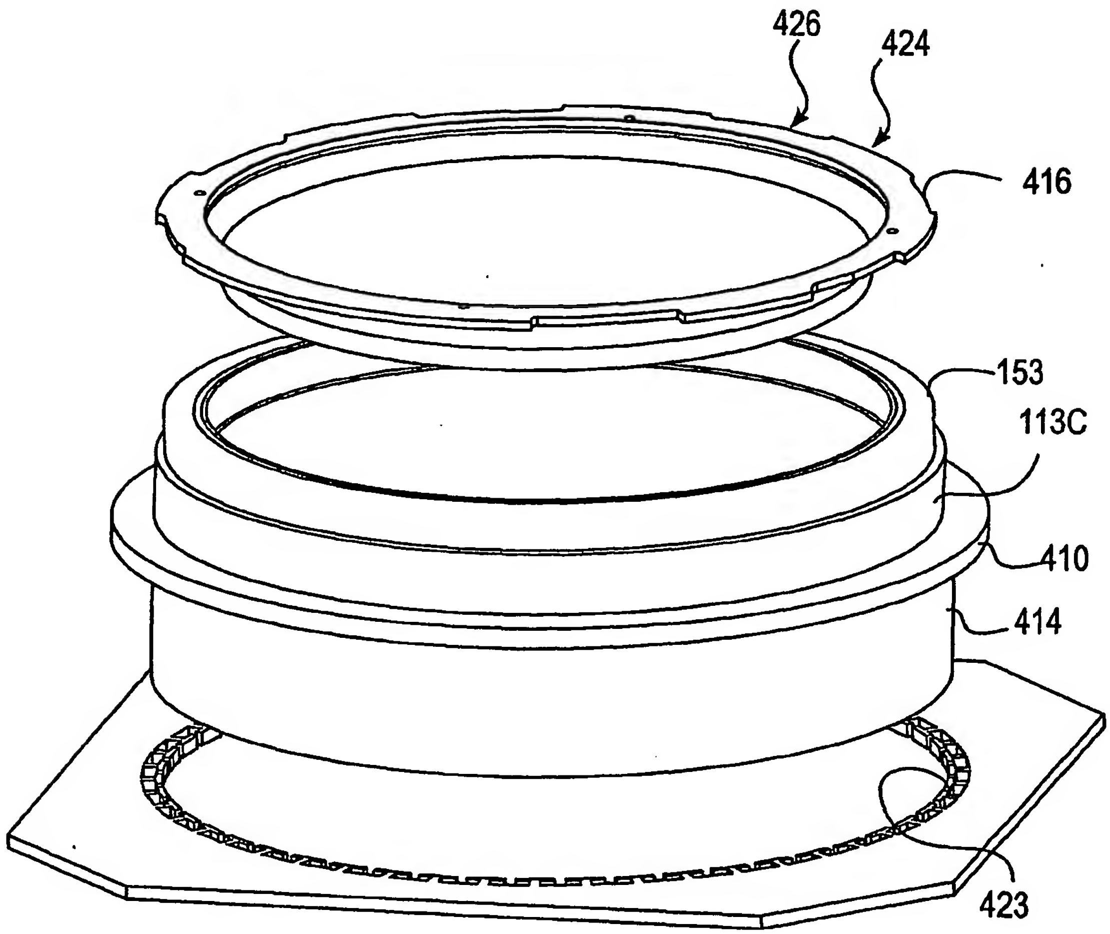

Fig. 8

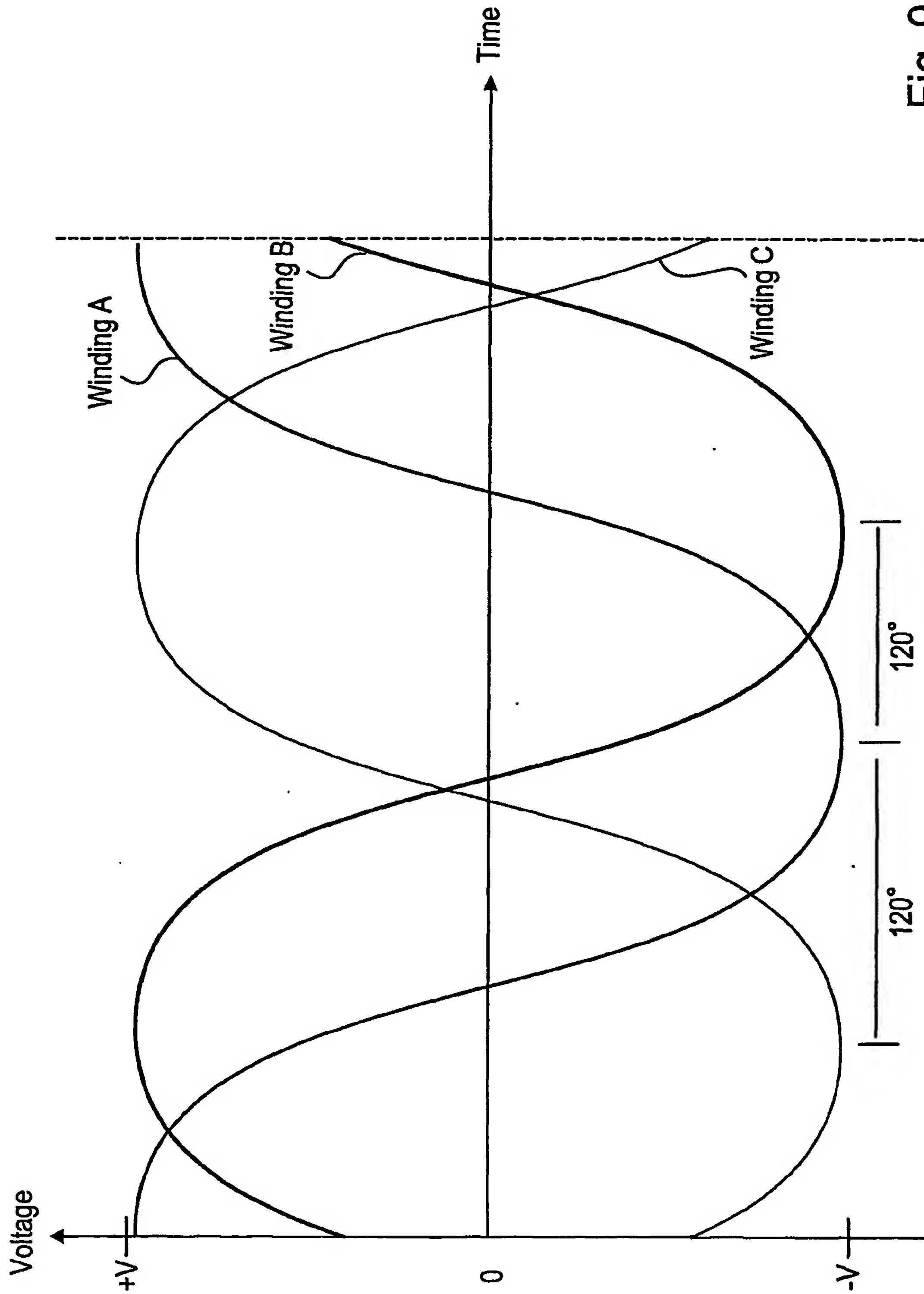

Fig. 9

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/20041

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02K7/08 H01L21/00 F16C32/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02K H01L F16C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 818 137 A (GONDHALEKAR VIJAY ET AL) 6 October 1998 (1998-10-06) column 3, line 65 -column 4, line 50 figures	1-26
Y	GB 2 153 305 A (SECR DEFENCE) 21 August 1985 (1985-08-21) abstract; figure 2	1-26
A	EP 0 875 685 A (NTN TOYO BEARING CO LTD) 4 November 1998 (1998-11-04) column 2, line 44 -column 8, line 50	1-26
A	US 5 997 963 A (WEINER KURT W ET AL) 7 December 1999 (1999-12-07) abstract; figure 1	1-26

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2001	06/12/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ramos, H

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 01/20041

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5818137	A	06-10-1998	CA	2233707	A1	01-05-1997
			EP	0876702	A1	11-11-1998
			JP	11513880	T	24-11-1999
			WO	9715978	A1	01-05-1997
			US	6049148	A	11-04-2000
GB 2153305	A	21-08-1985	NONE			
EP 0875685	A	04-11-1998	JP	11013759	A	22-01-1999
			EP	0875685	A2	04-11-1998
			JP	11013760	A	22-01-1999
			JP	11013761	A	22-01-1999
			JP	11013762	A	22-01-1999
			US	6288465	B1	11-09-2001
US 5997963	A	07-12-1999	EP	1082470	A1	14-03-2001
			WO	9957331	A1	11-11-1999